

Goongarrite, a new mineral from Comet Vale, Western Australia.

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A long series of minerals is known having the general formula $xM''S.yM'''_2S_3$, in which M'' is Pb, Hg, Fe, Ag_2 or Cu_2 , and M''' is As, Sb or Bi, whilst the ratio $x:y$ ranges from 1:6 to 12:1. Sixty-two species of this series have been more or less satisfactorily established: some of them of quite common occurrence, such as the "fahl ores," others confined to small accumulations in single localities. Such a series is unusual in the mineral kingdom, and is reminiscent of some of the series of carbon compounds.

Of the group in which $x:y$ is 4:1, only two representatives have previously been described*, viz., jordanite, $4PbS.As_2S_3$, and meneghinite, $4PbS.Sb_2S_2$. A mineral recently discovered at Comet Vale on the shores of Lake Goongarrie, forms a third member of this series, having the formula, $4PbS.Bi_2S_3$. For this new mineral the author proposes the name "Goongarrite."

The mineral forms three or four per cent. of the total mass of a quartz vein occurring in an Archaean amphibolite which Jutson† shows to be traversed by small quartz porphyry dykes, derived from a granite mass situated only half-a-mile away to the north. A little of the mineral has also been found in the amphibolite close to the vein. Attention was first drawn to it owing to the high silver results (up to 140oz. to the ton) obtained when portions of the vein were subjected to fire assay.

Goongarrite forms small irregular masses, plates and strings in translucent quartz, no other metallic minerals except native gold and the products of its own weathering being associated with it. The structure of the mineral in the smallest masses is somewhat fibrous, but the larger masses may be described as platy sub-fibrous, the thin plates which are produced by crushing having a tendency to be much longer than they are wide. This sub-fibrous, often slightly radiating structure, is at times discernible on sections of the masses not parallel to a prominent cleavage. This cleavage, which is apparent in all fragments, shows most of the masses of the mineral to be composed of more than one individual. A second cleavage not at right angles to the first is often to be seen on the larger individuals. It may represent the second face of a prismatic cleavage.

* There is a doubt whether the fahl ores belong to this group or the 3:1 group. Possibly they include members of both groups.

† Geological Survey of W.A. Bulletin No. 79.

No crystal structure, beyond the cleavages, was observed except in the case of one small mass in which several other imperfect faces could be seen with a lens. This was partly freed from the enclosing quartz and other goongarrite individuals and set up in a Goldschmidt two circle goniometer.

The following readings were obtained:—

Face.	Polar distance.		Azimuth.		Notes.
m ¹ unit prism ...	90°	0'	36°	41½'	Large, excellent image.
m ⁴ unit prism ...	90°	0'	—	36° 41½'	Large face.
b ¹ clinopinacoid ...	93°	23'	90°	44'	do.
b ² clinopinacoid ...	92°	41'	—	90° 40'	do.
x prism ...	95°	1'	—	18° 36'	Very small.
y prism ...	89° ±		—	75° 11'	do.
r unit hemi-dome	44°	14'	—	0° 3'	Large.
v unit hemi-dome	51°	17'	179°	22'	Number of disconnected facets.
r pyramid ...	63°	29'	70°	16'	Small brilliant.
s pyramid ...	58°	27'	113°	14'	do.
t pyramid ...	16°	29'	—	60° 6' ±	Very small.
pyramid ...	9°	42'	—	123° 33' ±	do.

The nomenclature of the faces in this table must be looked upon as tentative only, in view of the single imperfect crystal measured and the rather poor and often multiple images obtained from all the faces except that marked m¹. The several faces in the prism zone did not yield a uniform polar distance, hence several settings were tried. The final figures adopted in the table were based upon a setting which assumed the edge m¹m⁴ to be parallel to the vertical axis. Three separate settings gave the following angles in the prism zone:—

Setting.	m ¹ m ⁴ .		m ¹ b ¹ .		m ⁴ b ² .	
A	72°	23'	54°	41'	54°	28'
B	72°	27'	54°	18'	54°	0'
C	72°	9'	54°	40'	54°	36'

Dana gives for jordanite and meneghinite respectively—m¹m⁴, 56° 31', 55° 45': m¹b¹, 61° 45', 62° 8'.

The figures obtained do not enable the crystallisation of goongarrite to be determined but they are not at variance with the inference that like its two congeners, this mineral is monoclinic.

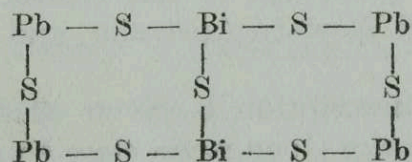
The density determined with a pycnometer on the fine powder is 7.29. From this the molecular volume is calculated to be 202. That of jordanite with $d = 6.39$ is 188: that of meneghinite with $d = 6.40$ is 202. The mineral is brittle, with a hardness on Mohs' scale of 3.0.

Goongarrite is irregularly distributed through the quartz, and in order to obtain material for analysis, several of the richer portions of the vein filling were crushed to pass a 90 mesh sieve and then treated several times with methylene iodide of density 3.3 to remove quartz and any other light mineral. Finally it was hand-picked under a lens to remove any visibly composite grains. The material so collected was found still to carry 1.72 per cent. of quartz. After deducting this, the results of the analysis were:—

Goongarrite, Comet Vale—

			per cent.	mols.	
Lead, Pb	54.26	2,619	} 2,707
Zinc, Zn	...	...	.06	9
Iron, Fe	...	...	.17	30
Silver, Ag	...	...	1.05	97 ÷ 2
Gold, Au	...	...	Nil	...
Bismuth, Bi	28.81	1,378	} 1,387
Antimony, Sb	...	...	.11	9
Arsenic, As	...	...	Nil	...
Sulphur, S	15.24	4,573	} 4,783
Selenium, Se	...	...	.24	30
Tellurium, Te	Nil		
			99.94		

Only vessels of silica and platinum were used in the analyses and double precipitations of each constituent were made whenever possible. The molecular ratios are 3.96: 2.03: 6.99 which are very close to 4: 2: 7 required by the formula $4\text{PbS}.\text{Bi}_2\text{S}_3$. The structural formula may be—



The appreciable percentage of silver in the mineral is much greater than that recorded for any specimens of jordanite or meneghinite, but other members of the series $x\text{MS}.\text{yM}_2\text{S}_3$ in certain regions contain large proportions of this metal, *e.g.*, andorite, the fahl ores, etc.

The absence of arsenic from goongarrite, and the almost total absence of antimony is noticeable. In this connection it is to be

observed that no bismuth and only very small amounts of antimony have been found in jordanite, whilst no bismuth and only very small amounts of arsenic have been found in meneghinite. In the presence, however, of large amounts of lead, such as occur in these minerals, it is possible that small amounts of bismuth have been overlooked.

Small proportions of selenium, such as were found in this mineral, are not uncommon in the double sulphides of lead, bismuth, etc.

The most striking product of weathering observed in the upper portions of the deposit, both in the quartz vein and adjacent amphibolite, is bright yellow bismutite, both as direct pseudomorphs and as films in adjacent fractures. Massive grey cerussite is similarly distributed and at times a little anglesite can be detected by chemical tests. It is probable that the relatively high silver contents of some of the well oxidised ore is due to the presence of cerargyrite, but there is no ocular evidence of it.

The chemical properties of goongarrite so far determined are as follow :—

Strong (10E) hydrochloric acid decomposes the mineral in the cold, with rather rapid evolution of hydrogen sulphide, the process being hastened by slight warming. Solution is complete except for traces of silver sulphide and chloride.

Dilute (5E) nitric acid has very little effect even upon heating, but stronger acid attacks the mineral rapidly giving a white residue of lead sulphate.

Out of contact with air the mineral fuses below 950°C . and in a closed tube gives a slight sublimate of Sb_2OS_2 . Heated in the air white fumes are given off and large volumes of sulphur dioxide. If the heat be applied gradually to a porcelain crucible containing the mineral, and the temperature be finally raised to a bright red heat globules of a lead-bismuth alloy form, probably by interaction of PbS and Bi_2S_3 with PbSO_4 formed during the early stages of the roasting.

The type of this mineral is in the author's collection, whilst co-types have been presented to the Western Australian Museum, Geological Survey of Western Australia, and University of Western Australia.

Summary.—A description is given of a new mineral coming from the shores of Lake Goongarrie close to the township of Comet Vale. It is named Goongarrite. Its composition is $4\text{PbS}.\text{Bi}_2\text{S}_3$, forming the third member of the series which includes the two previously known minerals, jordanite ($4\text{PbS}.\text{As}_2\text{S}_3$) and meneghinite ($4\text{PbS}.\text{Sb}_2\text{S}_3$).